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Ricks

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[54] **AIR PURGING AND SHUT-DOWN SYSTEM FOR DIESEL ENGINES**

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[51] **Int. Cl.**[5] **F02M 39/00**; F02K 31/1

[52] **U.S. Cl.** .... **123/516**; 123/510; 123/198 DB

[58] **Field of Search** .... 123/510, 512, 514, 516, 123/198 D, 198 DB

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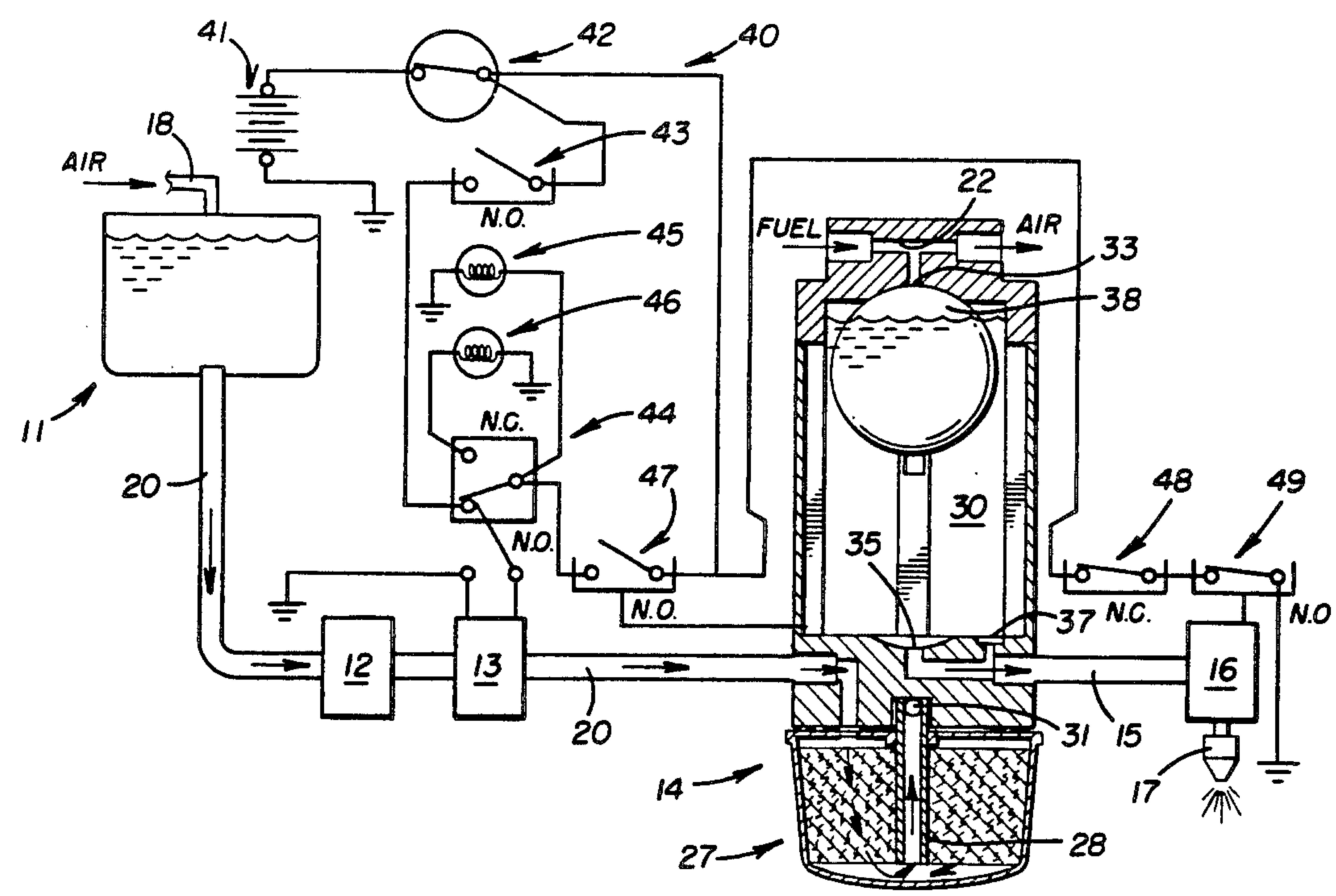
[57] **ABSTRACT**

A fuel system for a diesel engine includes an air purging system for venting trapped air to a vent line connected to a fuel tank and an emergency shut-down system for providing a fail-safe shut-down of the engine when fuel is low. The air-purging system comprises a device defining a float chamber having an air outlet communicating with the vent line, a fuel inlet, and a fuel outlet. A float is disposed in the chamber and is adapted to move between a normal first position closing the air outlet, an emergency intermediate second position opening both the air and fuel outlets, and a shut-down third position opening the air outlet and closing the fuel outlet. The emergency shut-down system includes electronic and pressure sensitive switches, warning lights, and an auxiliary fuel pump to monitor and control the shut-down and restart modes of engine operation. The air purging system is adapted to function independently of the emergency shut-down system.

19 Claims, 2 Drawing Sheets



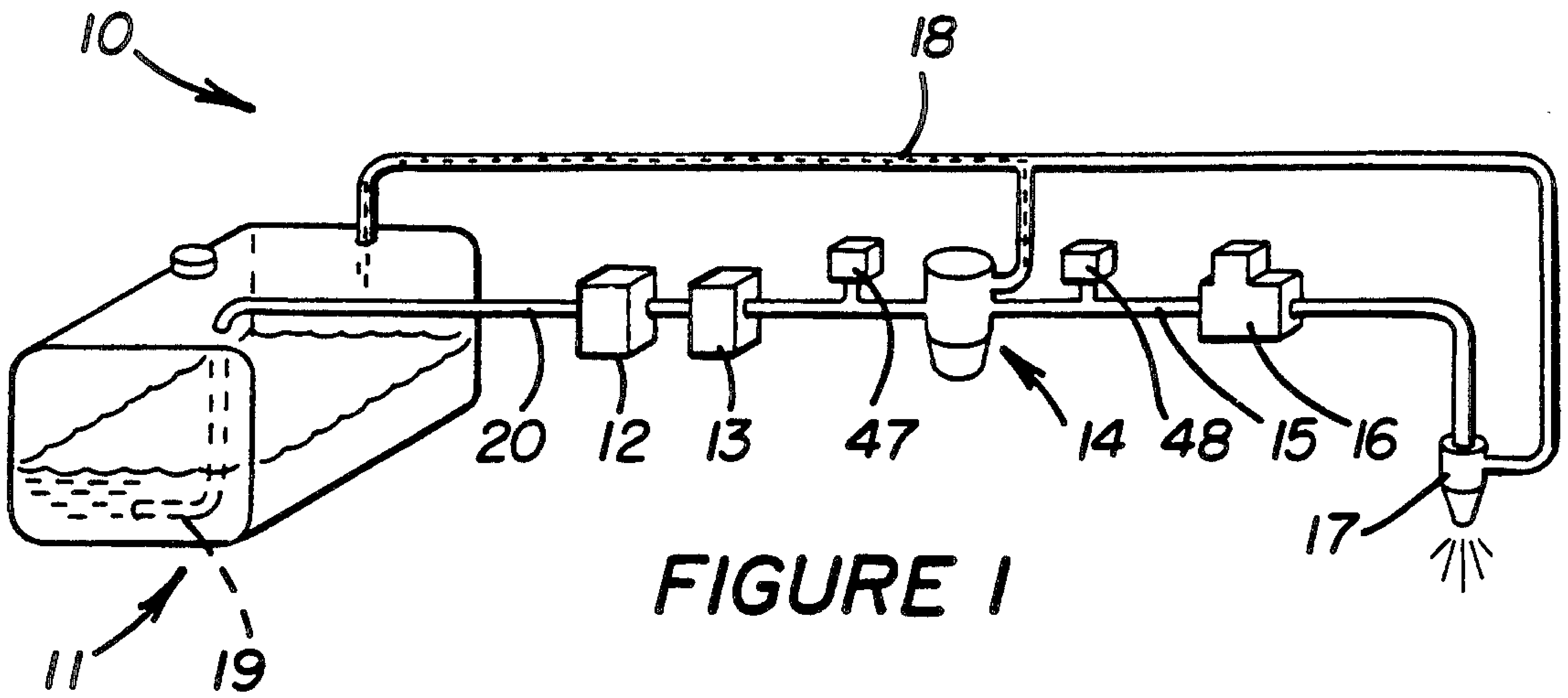


FIGURE 1

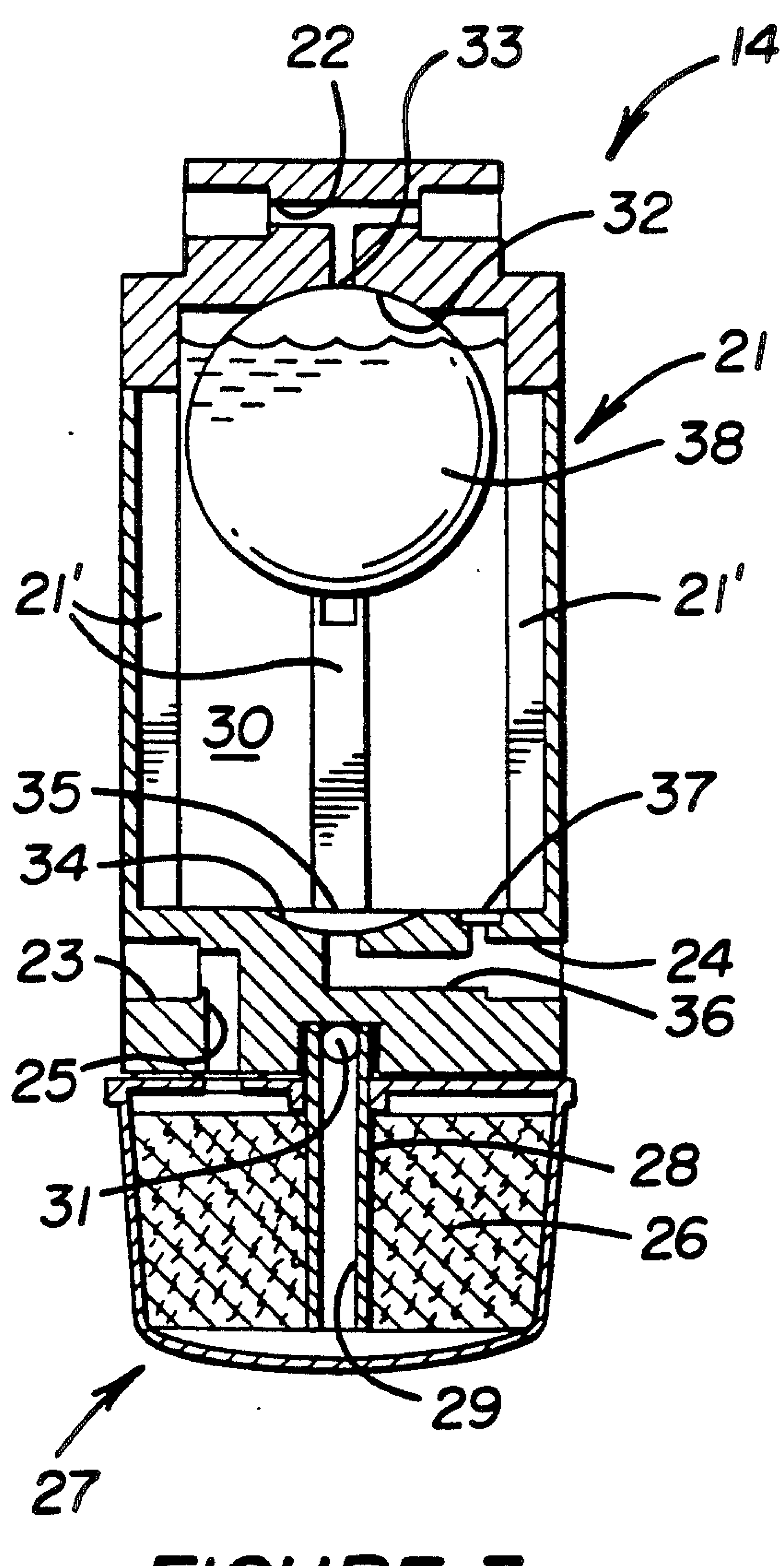


FIGURE 3

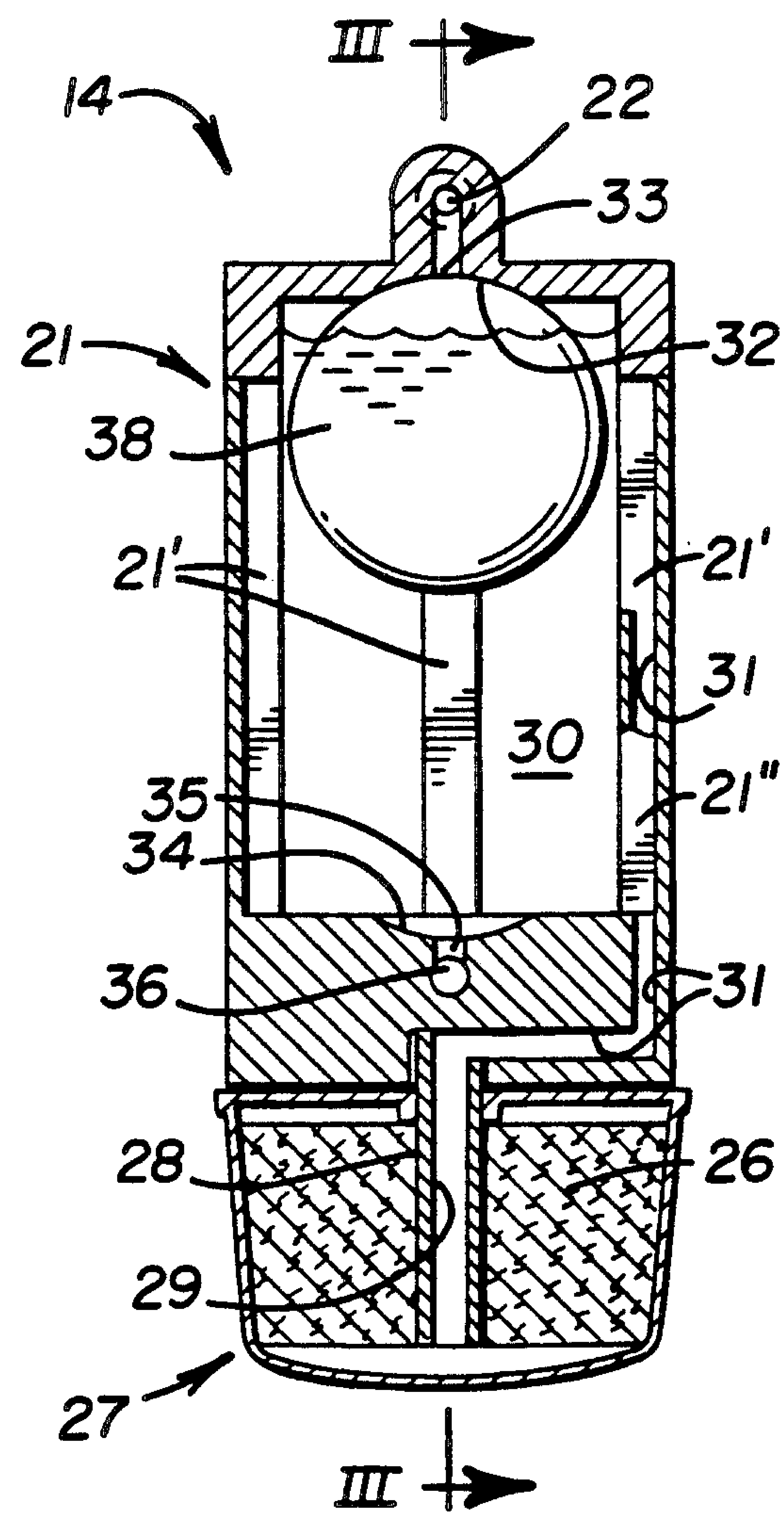


FIGURE 2

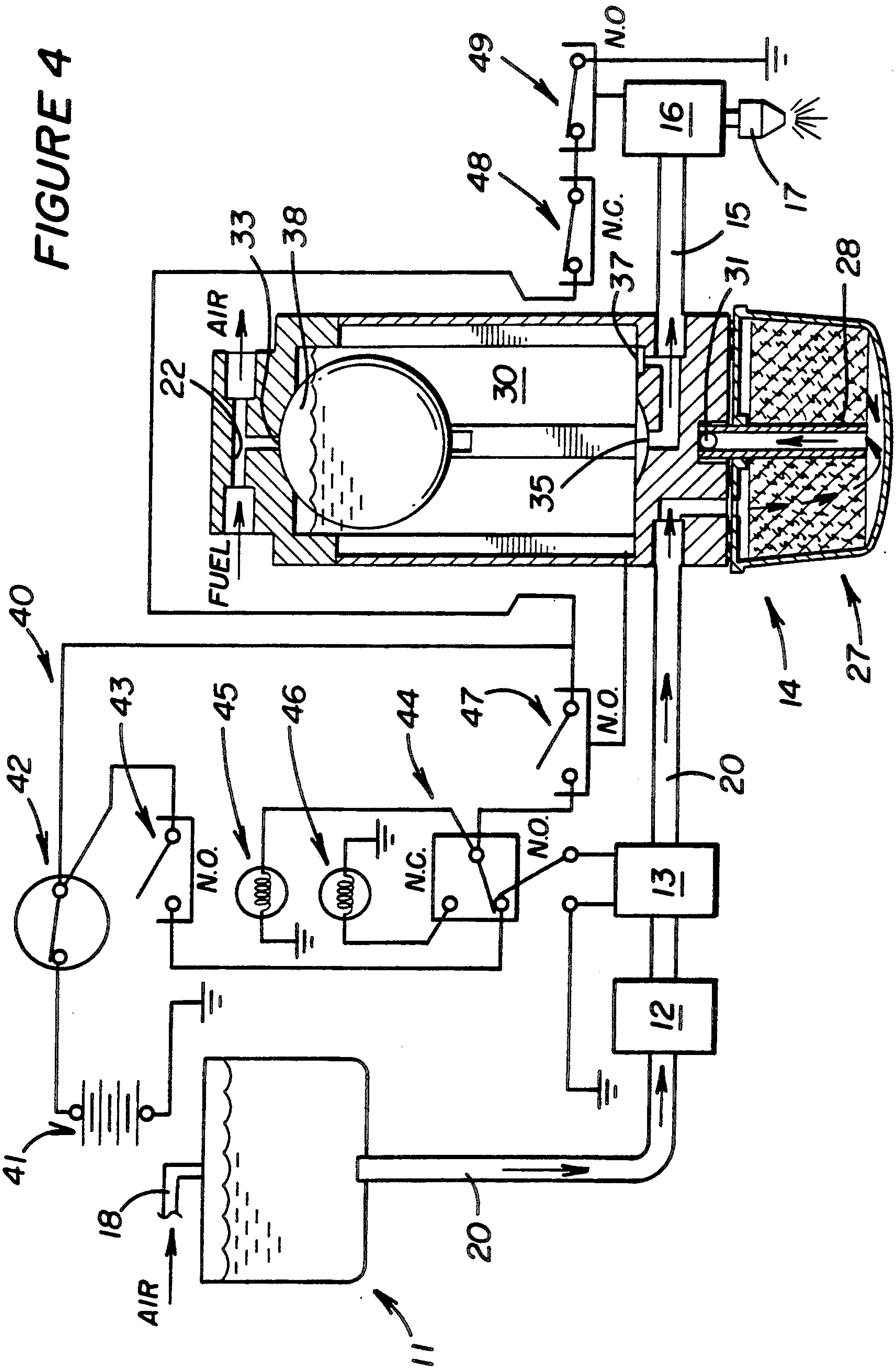

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FIGURE 4

AIR PURGING AND SHUT-DOWN SYSTEM FOR DIESEL ENGINES

TECHNICAL FIELD

This invention relates generally to a fuel system for a diesel engine and more particularly to a control system for purging air from an engine's fuel line and for facilitating engine shut-down and start-up.

BACKGROUND OF THE INVENTION

The standard fuel system for a diesel engine includes, in connected series, a tank adapted to contain liquid diesel fuel therein, a transfer pump, injection pumps and a plurality of injectors for injecting diesel fuel into the combustion chambers of the engine. When the fuel in the tank of a vehicle is low and the vehicle stops abruptly, starts or sharply changes its attitude, air will tend to enter the fuel line to the injection pumps to induce engine stalling. It is common practice to install a sock-like steel mesh strainer at the outlet from the fuel tank to aid in counteracting the air vortexing and cavitation effect that induces engine stalling.

However, use of this type of strainer is not totally efficient and will not prevent air from entering the fuel line when the fuel tank becomes empty and also when the engine is restarted after refilling of the tank. In either situation, stalling of the engine normally requires towing of the vehicle to a service facility for the purpose of removing air from the fuel lines to enable the engine to be restarted. Further, strainers of this type periodically become clogged and require removal of the fuel tank for cleaning and replacement purposes. This procedure is unduly expensive and involves substantial "downtime."

Various devices have been proposed for the purpose of preventing the communication of air through the fuel line and to the fuel pumps of an engine when the fuel in the tank drops below a predetermined low level. For example, U.S. Pat. No. 4,602,605 discloses an automatic shut-off device for the fuel system for a diesel engine wherein a float switch is actuated to shut an engine down in response to the fuel dropping below such a low level in the fuel tank. The device has a bleed orifice that allows trapped air to escape and return to the fuel tank when the tank is refilled with fuel. Various other systems have been used in fuel systems of this type to purge air therefrom.

Conventional systems of this type are generally complex in construction and do not insure the reliability required. For example, adequate fuel is not provided, after the driver has been alerted that a "low fuel" or clogged fuel filter condition of engine operation exists, to permit the driver to safely drive off a roadway. Further, no provision is made for restarting the engine expeditiously.

SUMMARY OF THE INVENTION

An object of this invention is to provide an improved and economical air purging and emergency shut-down control system for the fuel system of a diesel engine that is non-complex, highly dependable and efficient in operation, provides adequate fuel for safety purposes before engine stalling, and insures expeditious restarting of the engine, without bleeding of the fuel lines, after an empty fuel tank is re-filled.

In one aspect of this invention, the air-purging portion of the control system comprises an air-purging device defining a float chamber having an air outlet communicating with a vent line connected to a fuel tank, a fuel inlet for receiving fuel from a transfer pump, and a fuel outlet for communicating fuel to an injection pump for a fuel injector. A float, having a specific gravity less than that of the fuel, is freely suspended in unattached relationship in the float chamber for movement between a first position closing the air outlet and a second position closing the fuel outlet when the float chamber is at least substantially empty of fuel. In the preferred embodiment of this invention, an orifice is provided to continuously communicate the float chamber with the injection pump when the fuel outlet is closed.

The air-purging device will insures that no air is trapped in the fuel line connecting the device with the injection pump during normal engine operation and also after the empty fuel tank has been refilled. Further, the device eliminates the need for the above-discussed-type of strainer, normally attached to the outlet from a conventional fuel tank.

In another aspect of this invention, an emergency shut-down system comprises means for insuring adequate fuel for limited engine operation and for further insuring expeditious restart of the engine.

Although the invention described herein finds particular application to diesel engines, it should be understood that it can be adapted for use with other types of internal combustion engines, such as gasoline and methanol engines.

BRIEF DESCRIPTION OF THE DRAWING

Other objects and advantages of this invention will become apparent from the following description and accompanying drawing wherein:

FIG. 1 schematically illustrates a fuel system for a diesel engine, including an air purging system therefor;

FIG. 2 is a cross-sectional view through an air-purging device of the system;

FIG. 3 is a cross-sectional view through the air-purging device, taken in the direction of arrows III—III in FIG. 2; and

FIG. 4 schematically illustrates an emergency shut-down system integrated into the fuel system.

DESCRIPTION OF THE PREFERRED EMBODIMENT

FIG. 1 illustrates a fuel system **10** for a diesel engine comprising, in connected series, a fuel tank **11**, an engine-driven transfer or main fuel pump **12**, an electrically driven auxiliary fuel pump **13**, an air purging or anti-air-lock device **14**, a branch fuel or suction line **15**, fuel distributing means in the form of a solenoid-actuated injection pump **16** and an injector **17** for each cylinder of the engine. Excepting air purging device **14** and auxiliary fuel pump **13**, the remaining basic components of the fuel system are conventional and function in a well-known manner. For example, suitable filters (not shown) may be provided for engine-driven fuel pump **12** and injection pump **16** in a conventional manner.

Air purging device **14** functions to prevent air from being communicated to injection pump **16** during normal engine operation and also when the fuel in fuel tank **11** is at least substantially depleted. Air purging device **14** is connected to a vent line **18** which, in turn, is connected to fuel tank **11** to provide an air-purging system for air venting purposes. The vent line is preferably also connected to injector **17** to return excess fuel to the tank.

Conventional fuel systems of this type normally include a standard sock-like steel mesh strainer **19** connected to the inlet to a main fuel line **20**, terminating in the fuel tank. The strainer is intended to counteract air vortex effects normally occasioned in the fuel tank, as will be appreciated by those skilled in the diesel engine art. Air purging device **14** eliminates the need for such a strainer, which has given rise to the problems enumerated above.

Referring to FIGS. **2** and **3**, air purging device **14** comprises a multi-part housing **21** disposed on a central vertical axis thereof. A vent passage **22** is defined in the housing and is adapted for connection to vent line **18** by a standard fitting. The housing further defines a fuel inlet **23** adapted for connection to fuel line **20** (FIG. **1**) and a fuel outlet **24** adapted for connection to suction line **15**.

Fuel entering housing **21** from fuel inlet **23** passes through an inlet passage **25** and through a filter **26** of a standard (e.g., Fram Part No. P-3726) separator and filter assembly **27**, detachably mounted on the lower end of the housing. The assembly further includes a siphon tube **28** defining an internal passage **29** for communicating the filtered fuel to a float chamber **30** via a passage **31** defined in housing **21** (FIG. **2**). A semi-spherically shaped upper seat **32** has an air outlet **33** from float chamber **30** defined centrally therein that communicates with vent passage **22** and vent line **18** (FIG. **1**).

A semi-spherically shaped lower seat **34** has a fuel outlet **35** from the float chamber defined centrally therein. Outlet **35** communicates with fuel outlet **24**, connectable to suction line **15**, via a passage **36** (FIG. **3**). A restricted passage or orifice **37** continuously communicates float chamber **30** with passage **36** for purposes described hereinafter. Orifice **37** may be formed through a standard bleed disc, e.g., ⅜″×**150** ″ sintered bronze bleed disc manufactured by Pacific Sintered Metal, Inc. under Part No. F-100.

A spherically-shaped ball float **38**, having a specific gravity less than that of the fuel, is freely suspended in unattached relationship within float chamber **30**. The ball float is adapted to move between: (1) A normal first position (FIGS. **2–4**) engaging upper seat **33** when the float chamber is at least substantially full of fuel to close air outlet **33** and open outlet **35**; (2) An emergency intermediate second position opening both outlets **33** and **35**; and (3) A shut-down third position engaging lower seat **34** to close outlet **35** when fuel tank **11** and the float chamber are at least substantially empty of fuel. Upper and lower seats **32,34** and outlets **33,35** are aligned vertically and the diameters defining the seats and ball float **38** are identical.

Ball float **38** is in the form of a sphere having a diameter preferably selected from the approximate range from 1.5 in. to 3.5 in. The specific gravity of the ball float is preferably selected from the approximate range from 0.50 to 0.95. The ball float may be entirely composed of a suitable natural or synthetic elastomeric material, such as a suitably composed Buna "N" material or its equivalent, preferably having a durometer hardness selected from the approximate range of from 20 to 60.

The spherical shape and elasticity of the ball float will insure a positive static seal on outlet **33** when the ball float is in its FIG. **2** solid line position due to the closing force imposed thereon by the pressurized fuel in chamber **30**. As described hereinafter, the ball also insures a positive static seal on outlet **35** when chamber is emptied due to the differential pressure occasioned thereacross. The identical spherical shapes of the ball float and seats **32,34** will insure such static seals for all rotative positions of the ball float in float chamber **30**. The inside diameters of a plurality of guide ribs **21′** formed internally on housing **21** and extending radially into float chamber **30**, are only slightly larger than the diameter of the ball float. The vertically and circumferentially disposed ribs will precisely guide vertical movements of the ball float, essentially on the central vertical axis of device **14**, to insure the above-discussed static sealing desiderata.

A lower portion **21′** of one of the ribs has the termination of passage **31** formed therein with the face plate of the upper portion of the rib being slotted or removed to expose the passage to chamber **30**. Alternatively, a separate and shortened fifth rib (not shown) could be formed internally on housing **21** to define the termination of passage **31** therein. Such a rib would terminate short of the upper wall of the housing and would have the outlet from passage **31** defined thereat.

Bleed passage o orifice **37** functions to communicate a predetermined low volume of fuel flow from float chamber **30** to fuel outlet **24** when ball float **38** is in its closed position on lower outlet **35**. Although normally insufficient to support idling of the diesel engine, the volume of fuel communicated to the fuel outlet (when available) is sufficient to free the ball float from lower seat **34** by normalizing the suction effect imparted to the ball float by operation of injection pump **16** when the fuel tank is at least partially filled, after it has emptied. The bleed orifice is preferably sized to have a constant cross-sectional area selected from the approximate range from 0.004 in.^{2} to 0.015 in.^{2}.

In normal operation and with fuel tank **11** having adequate fuel to maintain engine operation, float chamber **30** (FIGS. **2** and **3**) will be sufficiently full of fuel to permit ball float **38** to rise to its nested position on upper seat **32** to close outlet **33**. During an inclined mode of operation of the vehicle, for example, the lower open end of syphon tube **28** will remain immersed in fuel to insure continued engine operation. Air trapped in float chamber **30** will be vented to fuel tank **11** when float periodically unmasks outlet **33** during normal conditions of engine and vehicle operation.

FIG. **4** schematically illustrates an emergency shut-down (and restart) system **40** that includes monitor and control means that functions to automatically alert a driver that the fuel supply is nearing empty (e.g., one gallon) to provide sufficient time (e.g., five minutes) for a vehicle to be driven to safety. After a safe and controlled shut-down of the engine, the system further enables the engine to be restarted when fuel tank **1** is again at least partially filled. The emergency shut-down system remains inactive during normal engine operation and does not interfere with the normal operation of the above-described air purging system.

In the embodiment illustrated in FIG. **4**, integrated emergency shut-off system **40** includes the vehicle's battery **41** and a standard ignition switch **42** that must be closed in a conventional manner for the normal mode of engine operation illustrated. The ignition switch is connected in series to a cab-mounted and normally-open (spring biased) restart switch **43** and a two-position pressure responsive pump control switch **44**, connected to normally-off electrically-driven fuel auxiliary pump **13** for purposes explained hereinafter.

Switch **44** may be normally spring-biased to its illustrated first position in closed connection with a normally-off cab-mounted fuel pressure indicator light (or gage) **45**. Switch **44** is adapted to be tripped to a second position for closed connection to a normally-off cab-mounted emergency indicator light (or gage) **46**, as described hereinafter. In the illustrated first position of switch **44**, auxiliary fuel pump will be activated in response to a closing of a switch **47**.

Normally-open pressure responsive switch **47** is continuously connected to chamber **30** to sense fuel pressure therein and is adapted for closed electrical connection to either pump **13** or indicator light **46**, as dictated by the position of switch **44**. Ignition switch **42** is further connected in series to a normally closed pressure responsive vacuum switch **48**, connected to fuel suction line **15** on the upstream side of injector pump **16** to sense the fuel pressure therein. Switch **48** is connected to a standard normally closed solenoid switch **49**, controlling activation of the injection pump.

The above-referenced individual components comprising emergency shut-down system **40** are off-the-shelf items that can be purchased commercially. For example, electrically-driven auxiliary fuel pump **13** can constitute a Carter Model No. P4070. Switches **44**, **47** and **48** can be of the types manufactured by Stewart-Warner, Inc. and are identified as part Nos. 76078 (25-50 psi), 76585 (4.0 psi) and 4077 (2 in. V.S.M.), respectively.

The operation of the above-described air-purging and emergency shut-down systems will now be explained through the "NORMAL RUNNING," "WARNING," "SHUT-DOWN," and "RESTART" modes of engine operation.

NORMAL RUNNING MODE

FIG. **4** illustrates the air-purging and emergency shut-off systems in their respective normal conditions when the engine is being supplied with sufficient fuel to run normally. Ball float **38** will normally close-off outlet **33** to vent line **18** when no adverse air pockets or bubbles exist in float chamber **30** (FIGS. **2-4**) and downstream thereof to injector **17** (FIG. **1**). However, should air cavitation or the like occur in the system, the ball float will unseat to vent the trapped air back to fuel tank **11**, via passage **22** and vent line **18**. Emergency shut-down system **40** remains inactive and will not interfere with the normal operation of the air purging system.

WARNING MODE

In the event that fuel runs low as a result of normal engine operation or otherwise (e.g., clogged filter **26** or main fuel line break), the driver will be afforded sufficient fuel (e.g., one gallon) and time (e.g., five minutes) to drive his vehicle to safety. Referring to FIG. **4**, switch **47** will close automatically in response to a drop in fuel pressure in chamber **30** (e.g., below 4.0 psia) to illuminate warning light **45** and to activate electrically driven auxiliary fuel pump **13** to augment the pumping force of pump **12**. Unless filter **26** is clogged, pumps **12** and **13** will pump the remaining fuel in tank **11** and line **20** to float chamber **30** of air-purging device **14** to insure continued, but temporary, running of the engine. It should be noted that switch **47** could be connected only to fuel line **20**, but would not then provide the "clogged filter" alerting function.

During this temporary mode of engine operation, ball float **38** will drop in chamber **30**. Thus, outlet **33** will remain open to continuously vent air to the fuel tank via passage **22** and vent line **18**. The relatively reduced pressure in suction line **15**, occasioned by the running of injection pump **16**, will induce the remaining fuel in float chamber **30** to be communicated to injector **17**.

During this mode of operation, float chamber **30** functions as a reservoir for the temporary volume of fuel required to drive the vehicle to safety. In this sense, and due to connection of switch **47** to chamber **30**, air-purging device **14** can be considered a part of emergency shut-down system **40**.

SHUT-DOWN MODE

The system is activated to its SHUT-DOWN condition of engine operation in response to the absence of fuel pressure in main fuel line **20** and a negative pressure in suction line **15**. Automatically, switch **44** is tripped to its second position in response to an absence of fuel pressure in pump **13** to illuminate warning light **46** and switches **48** and **49** open in response to the absence of fuel pressure in line **15** to deactivate injection pump **16**. Ball float closes on outlet **35** of air-purging device **14**, but chamber **30** remains in communication with passage **36** and suction line **15** via orifice **37** for the following restart mode. The driver is thus able to drive his vehicle to a safe stop and inspect the system for an empty fuel tank condition, broken main fuel line, or other malfunction.

RESTART MODE

Assuming lack of fuel has been the problem, fuel tank **11** is at least partially filled to supply fuel pressure to line **20**. The driver will then temporarily close normally open spring-biased switch **43** to activate auxiliary fuel pump **13** to communicate fuel to chamber **30** of air-purging device **14**. The fuel further communicates to suction line **15** to close switches **48** and **49** automatically whereby the air-purging and emergency shut-down systems return to their normal conditions shown in FIG. **1** to commence normal engine operation.

Continuous communication of fuel from float chamber **30** to suction line **15**, via orifice **37**, will insure that ball float **38** will release from seat **34** to uncover outlet **35**. Otherwise stated, in the absence of orifice **37** the differential pressure across the all float would tend to hold the ball float on outlet **35**, i.e., the initial operation of fuel pump **16** would tend to draw a negative pressure in suction line **15** with outlet being exposed to ambient pressure via vent line **18**.

The following chart summarizes the above-described modes of operation, beginning with the normal mode of operation shown in FIG. **4**:

	MODE OF OPERATION			
SYSTEM COMPONENT	NORMAL	WARNING	SHUT-DOWN	RESTART
TANK 11	FULL	LOW	EMPTY	FULL
PUMP 12	ON	ON	OFF	ON
PUMP 13	OFF	ON	OFF	ON
PUMP 16	ON	ON	OFF	ON
CHAMBER 30	FULL	PARTIAL	EMPTY	PARTIAL
OUTLET 33	CLOSED	OPEN	OPEN	OPEN
OUTLET 35	OPEN	OPEN	CLOSED	OPEN

-continued

MODE OF OPERATION				
SYSTEM COMPONENT	NORMAL	WARNING	SHUT-DOWN	RESTART
ORIFICE 37	OPEN	OPEN	OPEN	OPEN
FLOAT 38	UP	INTER.	DOWN	INTER.
SWITCH 42	CLOSED	CLOSED	CLOSED	CLOSED
SWITCH 43	OPEN	OPEN	OPEN	CLOSED
SWITCH 44	1st POS.	1st POS.	2nd POS.	2nd POS.
LIGHT 45	OFF	ON	ON	ON
LIGHT 46	OFF	OFF	ON	ON
SWITCH 47	OPEN	CLOSED	CLOSED	CLOSED
SWITCH 48	CLOSED	CLOSED	OPEN	CLOSED
SWITCH 49	CLOSED	CLOSED	OPEN	CLOSED

The size of the float chamber **30**, required for a particular engine application, will largely depend on the size of such engine. For example, the capacity of the float chamber could approximate one pint for standard automobiles and small trucks whereas such capacity could be increased to approximately one gallon for large trucks, earth-moving equipment and the like. The shape (e.g., cylindrical, box-like, etc.) and construction (e.g., arrangement of fuel inlets and outlets, passages, etc.) of air-purging device can also be varied, as will be appreciated by those skilled in the art.

The specific gravity of ball float **38** may be selected from the range of from 0.50 to 0.95 and preferably from the range of 0.50 to 0.70. The latter, preferred range will insure floating of the ball in diesel fuels having specific gravities less than 0.95. For example, the specific gravities for diesel fuels sold in the State of California, Mexico and the mid-continent are approximately 0.954, 0.987 and 0.812, respectively.

I claim:

1. An air-purging system for the fuel system of an internal combustion engine having a fuel tank adapted to contain liquid fuel therein, a main fuel pump and fuel distributing means for communicating said fuel to combustion chambers of said engine, said air-purging system comprising

a housing defining a float chamber, an air outlet mean for communicating said float chamber with a vent line connectable to said fuel tank, fuel inlet means for communicating fuel from said fuel tank to said float chamber, and fuel outlet means for communicating fuel from said float chamber to said fuel distributing means, and

float means having a specific gravity less than said fuel and disposed in said float chamber for movement between a first position closing said air outlet, in response to said float chamber being at least substantially filled with said fuel, a second position opening both said air outlet and said fuel outlet in response to said float chamber being only partially filled with said fuel, and a third position closing said fuel outlet in response to said float chamber being empty of said fuel.

2. The air-purging system of claim **1** further comprising orifice means for communicating a predetermined low volume of fuel flow from said float chamber to said fuel distributing means when said float means is in its third position.

3. The air-purging system of claim **2** wherein said orifice means is sized to have a cross-sectional area selected from the approximate range of from 0.004 in.^{2} to 0.015 in.^{2}.

4. The air-purging system of claim **1** wherein vertically spaced upper and lower seats for said float means are defined in said housing and wherein said air outlet and said fuel outlet are defined in said upper and lower seats, respectively and are aligned vertically.

5. The air-purging system of claim **4** wherein said float means constitutes a spherical ball having a diameter selected from the approximate range of from 1.5 in. to 3.5 in. and said upper and lower seats are each semi-spherically shaped.

6. The air-purging system of claim **5** wherein said ball has a specific gravity selected from the approximate range of from 0.05 to 0.95.

7. The air-purging system of claim **5** wherein said ball is composed of an elastomeric material having a durometer hardness selected from the approximate range of from 20 to 60.

8. The air-purging system of claim **1** further comprising a separator and filter assembly attached to a lower end of said housing and connected between said fuel inlet means and said float chamber.

9. The air-purging system of claim **1** further comprising emergency shut-down means for automatically alerting an operator of said engine when said float means is in its second position and for supplying a sufficient amount of fuel to said fuel distributing means to temporarily maintain running of said engine.

10. An air-purging device for a diesel engine having a tank adapted to contain liquid diesel fuel therein, a transfer pump, a vent line connected to said tank, an injection pump, and an injector, said air-purging device comprising

a housing disposed on a vertical axis thereof and defining a float chamber, fuel inlet means adapted for supplying said float chamber with fuel, fuel outlet means adapted for communicating fuel from said float chamber to said injection pump, air outlet means adapted for communicating said float chamber with said vent line, and

spherically-shaped float mean shaving a specific gravity less than said fuel and freely suspended in unattached relationship in said float chamber for movement between a first position, a closing relationship on said air outlet means when said float chamber is at least substantially full of fuel, a second position opening both said air outlet mean sand said fuel outlet means when said float chamber is partially filled with fuel, and a third position on said fuel outlet means when said float chamber is empty of fuel.

11. The air-purging device of claim **10** further comprising orifice means adapted for continuously communicating a predetermined low volume of fuel flow, bypassing said fuel outlet means, from said float chamber to said injection pump.

12. The device of claim **11** wherein said orifice means has a cross-sectional area selected from the approximate range of from 0.004 in.^{2} to 0.015 in.^{2}.

13. The air-purging device of claim **10** wherein said air outlet means and said fuel outlet means are aligned vertically on said axis.

14. The air-purging device of claim 10 wherein said float means constitutes a spherical ball having a diameter selected from the approximate range of from 1.5 in. to 3.5 in. and a specific gravity selected form the approximate range of from 0.50 to 0.95.

15. The device of claim 14 wherein said ball is composed of an elastomer having a durometer hardness selected from the approximate range of from 20 to 60.

16. An emergency shut-down system for the fuel system of an internal combustion engine having a fuel tank adapted to contain a liquid fuel therein, a main fuel pump connected to said fuel tank by a fuel line, and fuel distributing means for normally communicating said fuel to combustion chambers of said engine, said emergency shut-down system comprising

monitor and control means for automatically (1) alerting an operator that the fuel in said fuel tank has fallen below a predetermined level, (2) providing said fuel distributing means and said combustion chambers with sufficient fuel to run said engine for a limited period of time, and (3) deactivating said fuel distributing means to stop communication of fuel to said combustion chambers after said fuel has been expended, said monitor and control means including normally open pressure-responsive first switch means closeable in response to the pressure in said fuel line falling below a predetermined level, operator-visible first indicator means for alerting said operator that the pressure of said fuel has fallen below said predetermined level in response to closing of said first switch means, and a normally inactive auxiliary pump means for being activated to pump fuel through said fuel line in response to closing of said first switch means.

17. The system of claim 16 further comprising normally-off operator-visible second indicator means for being activated to alert said operator in response to the absence of fuel pressure in said fuel line and a second pressure-responsive switch means trippable from a first position for activating said auxiliary pump means in response to closing of said first switch means to a second position for activating said second indicator means in response to an absence of fluid pressure in said auxiliary pump means.

18. The system of claim 17 further comprising normally closed switch means for opening to deactivate said fuel distributing means in response to an absence of fuel pressure at an upstream side of said fuel distributing means.

19. The system of claim 16 further comprising restart means for selectively activating said fuel distributing means.

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